Response of Spring Wheat Yield and Protein to Row Spacing, Plant Density, and Nitrogen Application in Central Montana

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Introduction

Montana is characterized by cool springs and short growing seasons. Plant growth and development is limited by plant growth resources, such as light, temperature, nutrients, and water. Cropping systems and agronomic management practices must maximize the efficient use of these resources. Spring wheat development and resource use efficiency may be improved by manipulating row spacing, plant density, and nitrogen (N) application. Previous studies indicate that timing and amount of N application will alter plant growth and tiller survival (Maidl et al., 1998; Westcott et al., 1997).

The objective of this study was to investigate effects of plant population, row spacing, and split-application of N on spring wheat yield and protein content.

Methods

A three-year field experiment was conducted at the Central Agricultural Research Center of Montana State University, near Moccasin, MT. McNeal spring wheat was planted in a tilled re-cropped field after yellow mustard in 2003 and 2004 and after spring lentil in 2005. There were four seeding rates (PD1 = 10, PD2 = 20, PD3 = 30, and PD4 = 40 seeds/ft^2) and two row spacings (RS1 = 6 in. and RS2 = 12 in.). A fertilizer mixture of 20 lb P_2O_5/a, 9 lb K_2O/a, and 13 lb S/a was applied with the seed at planting. Liquid N-fertilizer (30-0-0) was split-applied at a total rate of 90 lb N/a. The three N-fertilizer split application timing treatments were: FA1 = 100% at seeding, FA2 = 50% at seeding and 50% at tiller formation, and FA3 = 50% at seeding and 50% at shoot elongation. The liquid fertilizer was dripped between wheat rows using a modified herbicide sprayer with special calibrated openers, each having attached drop tubes. The experiment was arranged as a split-split-plot design with 4 replications. Plot size was 4 ft x 30 ft. A 4-ft wide plot drill with disk-type openers was used to seed the plots. Plots were planted on April 20, 23, and 25 in 2003, 2004, and 2005, respectively. Herbicides (Roundup and Bronate) were applied as pre-seeding and post emergence weed control, respectively.

Results

Spring wheat yield was much greater in 2004 than in 2003 and 2005 (Fig.1) because of timely rainfall and less summer drought stress. Narrow row spacing (6 in.) consistently produced greater grain yield than wide row spacing (12 in.) in all years. This was likely due to less competition for water and light, from both wheat and weeds. In addition, the soil in the narrow row spacing likely had less evaporative loss due to greater canopy shading. Spring wheat yield reached a plateau when plant density reached 30 plants/ft^2. Split-application of N did not significantly affect the spring wheat yields.

Protein content was not affected by row spacing, split-application of N, or plant density (Table 1). These results did not agree with Westcott et al. (1997) for irrigated wheat. The reason for lack of a yield and protein response to split-application of N was likely due to the nature of soil and climate conditions in Central Montana. In a dry year, such as 2003, with 90 lb N/a, the limiting factor for yield and protein was not N but other resources, such as water, heat, and light. Protein contents were generally high, especially in 2003, due to drought.

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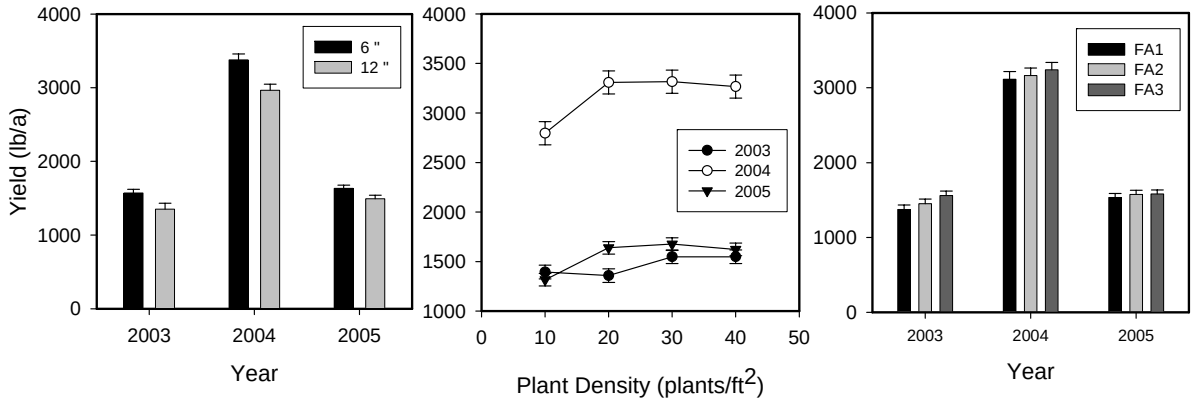

Figure 1. Spring wheat grain yield affected by row spacing (left), plant density (middle), and split-application of N (right). FA1 represents 100% N applied at seeding, FA2 represents 50% N applied at seeding and 50% N applied at tiller formation, and FA3 represents 50% N applied at seeding and 50% N applied at shoot elongation.

Table 1. Protein in spring wheat affected by row spacing, split-application of N, and plant density.

Treatment	2003	2004
	----Protein (%) ----	
6 in. spacing	18.0	16.2
12 in. spacing	18.0	16.2
100% N at seeding	18.0	16.3
50% N at seeding + 50% at tillering	18.2	16.3
50% N at seeding + 50% at elongation	17.8	16.1
10 plants/ft^2	17.7	16.3
20 plants/ft^2	18.0	16.0
30 plants/ft^2	18.1	16.3
40 plants/ft^2	18.2	16.3

Summary

Spring wheat yield is limited by lack of plant growth resources (e.g. heat, light, and water) in Montana. Row spacing and plant density greatly affected plant distribution patterns and space in the field, thereby affecting resource use efficiency. Manipulating row spacing and plant density is an effective practice to optimize tiller and main stem competition for light, water, and nutrition, therefore enhancing spring wheat grain yield and nitrogen use efficiency.

Fertilizer Facts:

- Split-application of N did not significantly affect spring wheat yield and protein content.
- Narrow row spacing increased spring wheat yield and therefore, increased N use efficiency.

References

Maidl, F.X., E. Sticksel, F. Retzer, and G. Fischbeck. 1998. Effect of varied N-fertilization on yield formation of winter wheat under particular consideration of main stems and tillers. J. Agron. and Crop. Sci. 180:15-22.

Westcott, M., J. Eckhoff, R. Engel, J. Jacobsen, G. Jackson, and B. Stougaard. 1997. Grain yield and protein response to late-season nitrogen in irrigated spring wheat. Fertilizer Fact: No.11. Montana State University, Agricultural Experiment Station and Extension Service.

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